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Contraceptive services, socioeconomic status, and teenage pregnancy in Finland – a longitudinal study

Eerika Jalanko, MD[1]; Frida Gyllenberg, MD, PhD[2]; Nikolas Krstic, MSc[3]; Prof Mika Gissler, PhD[4]; Prof Oskari Heikinheimo, MD, PhD[1]

[1]Department of Obstetrics and Gynecology, University of Helsinki and Helsinki University Hospital, Finland

[2]City of Vantaa, Finland

[3]Department of Statistics, University of British Columbia, Vancouver, BC, Canada

[4]Information Services Department, THL Finnish Institute for Health and Welfare, Helsinki, Finland

Correspondence to: Oskari Heikinheimo, Department of Obstetrics and Gynecology, University of Helsinki and Helsinki University Hospital, P.O. Box 140 FIN-00029 HUS.

oskari.heikinheimo@helsinki.fi. Tel: +358 50 4271533

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Abstract

Objectives Declining teenage pregnancy rates have been linked to improved access to youth-friendly contraceptive services, but information on the combined association of these services and socioeconomic factors with teenage pregnancy is lacking.

Design and setting This retrospective longitudinal register-based study covers the annual teenage childbirth and induced abortion rates in the 100 largest municipalities in Finland in 2000-2018. We investigated the combined association of regional, socioeconomic (i.e. education level and need for social assistance) and adolescent contraceptive service variables (i.e. free-of-charge contraception, over-the-counter emergency contraception (OTC EC), and an adolescent-only clinic) with teenage childbirth and induced abortion rates at the municipality level by using Poisson mixed-effects model.

Primary outcome measures Annual teenage childbirth and induced abortion rates as numbers per 1000 teenage girls aged 15 to 19 years old in the 100 largest municipalities in Finland from 2000 to 2018.

Results The following variables were significantly associated with both lower teenage childbirth and induced abortion rates when adjusted for all the other variables used in the model: providing free-of-charge contraception (RR 0·82 [95% CI 0·73–0·92] and RR 0·87 [95% CI 0·79–0·96], respectively), availability of OTC EC without age limit (RR 0·70 [95% CI 0·67–0·75] and RR 0·74 [95% CI 0·71–0·78], respectively), and high education level (RR 0·94 [95% CI 0·94–0·95] and RR 0·94 [95% CI 0·93–0·94], respectively).

Conclusion Providing free-of-charge contraception and availability of OTC EC without age limit are associated with lower teenage pregnancy rates. These services combined with proper counseling are thus important contents of youth-friendly contraceptive services. High-quality contraceptive services should be provided equally for all teenagers in order to further reduce teenage pregnancy rates.

Strengths and limitations of this study

- We investigated the association of health service and socioeconomic variables to annual teenage induced abortion and childbirth rates simultaneously in the same study setting from 2000 to 2018.
- The data covers practically all teenage pregnancies of the 100 largest municipalities in Finland based on the reliable Finnish health registers.
- The information on the availability of free-of-charge contraception and adolescent clinics was obtained from the questionnaire to the municipalities, and might thus be exposed to erroneous responses.

Introduction

Teenage pregnancy rates have been declining in Europe and in the U.S. for over a decade, although rates of both teenage childbirth and induced abortion vary by country.[1,2,3] Childbearing in adolescence is associated with adverse obstetrical outcomes,[4] as well as with socioeconomic and educational disadvantages.[5,6] Furthermore, women with a history of teenage pregnancy face an increased risk for psychiatric morbidity later in life.[6,7] As teenage pregnancy causes significant challenges at both the individual and the societal level, it is crucial to understand the factors associated with declining teenage pregnancy rates.

The downward trend in teenage pregnancy rates has mainly been linked to increased use of contraception,[2,3,8] especially that of long-acting reversible contraceptives (LARC) – i.e. intra uterine devices (IUD) and implants.[2,9] Further, the availability of accessible and/or affordable contraceptive services have been found to increase the use of contraception among adolescents and decrease teenage pregnancies.[10,11]

Providing free-of-charge contraceptives removes the financial barrier to contraception and associates with lower teenage pregnancy rates.[12,13] Specifically, offering free-of-charge LARC methods has been identified as an effective approach to prevent teenage pregnancy.[12,14] In addition to reducing financial barriers, providing information and counseling on contraception as part of school curricula and health care has been shown to increase adolescents' contraceptive use.[10] Moreover, expanding contraceptive services outside the clinical setting, e.g. by providing contraceptive methods over-the-counter (OTC), might potentially decrease the rate of teenage pregnancy.[15,16] However, providing OTC emergency contraception (EC) has not been shown to affect adolescent pregnancy rates.[17,18]

Despite these observations, studies examining the combined effects of both socioeconomic status and contraceptive services on teenage pregnancy rates are lacking. In Finland, the municipalities are obligated to offer family planning services for all citizens since 1972.[19] However, it is not specified

where and how the services should be arranged. Therefore, access to contraceptive services, as well as the content of the services differs between municipalities. In this study, we used information on how the contraceptive services are arranged together with information from Finland's reliable health registers,[20] to analyze the combined effect of contraceptive service models and the socioeconomic profile of the municipalities, on the teenage pregnancy rates in the population. Specifically, our aim was to identify to what extent certain socioeconomic factors and features of contraceptive services associate with teenage pregnancy rates at the municipality level.

Methods

In this longitudinal register-based study, we investigated the association of regional, socioeconomic and contraceptive service variables, with the annual teenage birth and induced abortion rates of the 100 largest municipalities in Finland, from 2000 to 2018. Hence, the data encompasses 1 900 measurement points across the follow-up.

In 2018, there were 311 municipalities in Finland. The total population in Finland was 5.5 million, and most of the municipalities are sparsely populated. We included the 100 largest municipalities based on the population in 2018 in this study. We considered all municipal mergers from 2000 through 2018, and the annual municipal division corresponds to that in 2018. The population in these municipalities ranged from 9 862 to 648 042 with a total of 4 631 980, and accounted for 84% of the total population in 2018.

Outcomes

Our primary outcomes were the annual rates of teenage childbirth and induced abortion in each municipality between 2000 and 2018. We defined teenager as being aged 15 to 19 years at the time of childbirth or induced abortion. We calculated the crude annual rates of childbirth and abortion as counts per 1000 women aged 15 to 19 years in the given municipality.

Data on childbirths and induced abortions were obtained from the Medical Birth Register and the Register of Induced Abortions, maintained by the Finnish Institute for Health and Welfare. The Medical Birth Register was established in 1987 and contains all livebirths and stillbirths with gestational age at least 22 weeks or infant weight at least 500 grams at the time of delivery, as well as data on mothers. The Register of Induced Abortions, available in electronic format since 1983, covers all induced abortions. Reporting to these registers is mandatory by law, and the accuracy of both registers is well validated.[20,21] However, these registers do not include miscarriages, i.e. pregnancies ending spontaneously before gestational weeks 22, or ectopic pregnancies. Hence, these pregnancies were not included in the study.

Explanatory variables

We assessed regional, socioeconomic and contraceptive service variables to examine the association with teenage pregnancy rates. The characteristics of the explanatory variables are shown in Table 1.

Table 1. Characteristics of the study municipalities stratified by the major regions.

	Helsinki-Uusimaa	Southern Finland and Åland	Western Finland	Eastern and Northern Finland	All major regions
Number of municipalities	16	24	33	27	100
Population in 2018	1 616 203	974 141	1 107 930	933 706	4 631 980
Degree of urbanization	96.4%	90.7%	89.1%	86.4%	91.4%
Socioeconomic factors*					
Social assistance recipients	6.07% ± 1.81 SD	6.14% ± 1.91 SD	5.78% ± 1.84 SD	7.14% ± 2.14 SD	6.28% ± 2.01 SD
Citizens with high education level	29.98% ± 5.87 SD	25.10% ± 4.40 SD	24.39% ± 5.91 SD	23.54% ± 5.32 SD	25.22% ± 5.82 SD
Contraceptive service factors**					

OTC EC for > 15-year-olds	16 (224)	24 (336)	33 (462)	27 (378)	100 (1400)
OTC EC for all ages	16 (64)	24 (96)	33 (132)	27 (108)	100 (400)
Contraceptive services centralized to an adolescent clinic	1 (19)	4 (61)	1 (19)	1 (10)	7 (109)
Free-of-charge contraception until the age of 20 or 25	4 (5)	2 (11)	9 (20)	10 (30)	25 (66)

*Data are in mean percentages across the follow-up from 2000 to 2018.

**Data are in numbers of municipalities offering the service, and (measurement points when the service was available in the municipalities).

OTC EC = Over-the-counter emergency contraception

SD = standard deviation

To visualize the change in teenage birth and abortion rates across follow-up, we aggregated the municipalities into larger areas based on the five major regions in Finland: Helsinki-Uusimaa (Capital region), Southern Finland, Western Finland, Åland, and Northern and Eastern Finland. However, Åland has only one municipality among the 100 municipalities included in the study, and was thus combined with Southern Finland, which is geographically closest to Åland. There were 16 municipalities in the Helsinki-Uusimaa region, 24 in Southern Finland and Åland, 33 in Western Finland and 27 in Northern and Eastern Finland. This regional division also describes the urbanization in different parts of Finland. The degree of urbanization refers to the proportion of people living in urban settlements among the population in the region. The degree of urbanization in 2018 in Helsinki-Uusimaa was 96.4%, in Southern Finland and Åland 90.7%, in Western Finland 89.1%, and in Northern and Eastern Finland 86·4%.

To describe the socioeconomic status of the residents, we used the percentage of adults receiving social assistance in each municipality, and the percentage of citizens with a high education level, that is either a university, a polytechnic degree, or studies of more than three years in a vocational institution. We obtained data on social assistance recipients from the Finnish Institute for Health and Welfare, and data on educational level from Statistics Finland.

To examine the association between contraceptive services and teenage pregnancy rates we used the following variables: availability for OTC EC, contraceptive services for adolescents centralized to an adolescent clinic, and possibility to receive any method of contraception except condoms free of charge until the age of 20 or 25. OTC EC became available in all pharmacies in Finland for over 15-year-olds in 2002 and without age restrictions in 2015.

To obtain information on how the contraceptive services were provided, we performed a questionnaire to the municipalities concerning centralization of adolescent contraceptive services and availability of free-of-charge contraception, and when the services had become available. The questionnaire was directed to the physicians corresponding the contraceptive services in each municipality. All 100 municipalities responded the questionnaire either by email or by phone. We received 20% of the responses from the first survey round conducted by email. The second email round increased the response rate to 60%, and the remaining responses we obtained by phone. Contraceptive services are mainly arranged in health centers, family planning clinics and/or school health care, but the initiation years of these services were not available in the responses. However, in seven municipalities the contraception services for adolescents were centralized to an adolescent clinic, and the initiation years of the clinics were available from the responses.

During 2000-2018, all municipalities offered at least a three-month supply of contraceptive pills free of charge to women initiating contraception. Altogether 25 municipalities offered all contraception free of charge until the age of 20 or 25, including pills, patches, vaginal rings, hormonal IUDs, copper IUDs and implants. The state of adolescent clinics and free-of-charge

contraception varied between the municipalities, but all municipalities offering these services continued them at least until the end of 2018, and there were no breaks in the services during the follow-up.

High education level and need for social assistance were treated as continuous variables (percentages on the unit scale), major region as a nominal variable (values 1 to 4 according to the major region), and OTC EC, adolescent clinic and free-of-charge contraception as binary variables (values 0 or 1). Binary variables were defined as having the value zero at measurement points where and when the service was not available, and the value one where and when the service was available. OTC EC was represented by two variables, each representing the policy implemented in 2002 for over 15-year-olds and in 2015 for everyone without an age restriction.

Statistical methods

To analyze the relationships between the explanatory variables and teenage childbirth and abortion rates, we used Poisson mixed effects models with the log of the 15- to 19-year old female population in each municipality per 1000 as offset.

Initially, we had obtained several socioeconomic variables from the registers of Statistics Finland, and we used a combination of the Variance Inflation Factor (VIF), the Akaike Information Criterion (AIC), and avoidance of non-convergent models, to select which socioeconomic variables to include in the model of teenage births. We used the AIC measure during forward model selection for socioeconomic variables, but included variables on contraceptive services and regional variables in our initial model, since these were our primary variables of interest. If the inclusion of a variable resulted in the greatest reduction in AIC compared to any other variable outside of the model, then we would attempt to include the variable. However, due to potential non-convergence of the model, likely because of multicollinearity or increased model complexity, we would select the variable that resulted in the greatest reduction in AIC while preserving convergence of the model. We repeated this process until any further inclusion of variables did not reduce the AIC. Subsequently, we

examined the VIF values of all variables to assess the level of multicollinearity present within the model. This selection procedure was used for modelling teenage births, while the same variables were included in the model of teenage induced abortions, to allow for direct comparisons. The model for teenage induced abortions did successfully converge. Furthermore, the VIFs in both models remained below 3 (values between 1 to 2.6), which is evidence of minimal to low multicollinearity impacting our model, and thus no factors were removed from the model. In addition to the final models, we also conducted univariate analyses for each variable included within the model without adjusting for other variables.

We present the results as rate ratios (RR) with 95% confidence intervals (CI) to assess the effect of each variable to the change in teenage birth and induced abortion rates by using comparisons appropriate for each factor. For regional variables the largest region of Helsinki-Uusimaa served as a reference level. For socioeconomic variables (i.e. the percentage of citizens with high education level and percentage of adults receiving social assistance) the rate ratios present the change in abortion and birth rates in relation to each percent unit increase in high education level or social assistance. For contraceptive service variables (i.e. OTC EC, contraception services centralized to an adolescent clinic and free-of-charge contraception until the age of 20 or 25) the rate ratios present the change in birth and abortion rates compared to the years and municipalities where the service was not available. Statistical significance of coefficient estimates within the model was determined using a significance level of 5%.

All analyses were conducted using R version 3.5.1 (R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/) and GraphPad Prism version 8.4.2 (GraphPad Software, San Diego, California USA, www.graphpad.com.)

Patient and public involvement

Due to the retrospective register study design, there was no patient and public involvement.

Results

There were altogether 20 544 teenage childbirths and 30 696 teenage induced abortions in the 100 municipalities in the years 2000 to 2018. Figure 1 shows the aggregated rates of annual unadjusted teenage childbirth and induced abortion in the four major regions during follow-up. Both childbirth and induced abortion rates decreased in all regions over time. The childbirth rates were highest in Northern and Eastern Finland throughout the follow-up, whereas the lowest birth rates were detected in the most densely populated region Helsinki-Uusimaa. By contrast, the induced abortion rates were higher in Helsinki-Uusimaa between 2002 and 2011 when compared to the other major regions, but thereafter the differences between the regions disappeared (Figure 1).

The characteristics of the municipalities stratified by major regions are presented in Table 1. Helsinki-Uusimaa was the most densely populated major region with total population of 1 616 203 in 16 municipalities. The highest mean percentage of adults receiving social assistance was seen in Northern and Eastern Finland, as well as the lowest percentage of citizens with high education level. Contraceptive services were most often centralized to an adolescent clinic in Western Finland, whereas free-of-charge contraception was offered most commonly in Northern and Eastern Finland. The policies of being able to purchase OTC EC came into effect at the same time in each municipality: in 2002 for over 15-year-olds and in 2015 for all ages.

The unadjusted and adjusted rate ratios from the mixed effects Poisson regression model for teenage childbirths and induced abortions are presented in Figures 2 and 3, respectively, showing the association between different variables and teenage pregnancy rates. The following variables were associated significantly with lower teenage childbirth rates after adjustment: major region Southern Finland and Åland (RR 0.83, 95% CI 0.69 – 0.99), high education level (RR 0.94, 95% CI 0.94 – 0.95), availability of OTC EC for all ages (RR 0.70, 95% CI 0.67 – 0.75), and providing free-of-charge contraception (RR 0.82, 95% CI 0.73 – 0.92).

For teenage induced abortions, the following variables were associated significantly with lower abortion rates after adjustment: major regions Southern Finland and Åland (RR 0.73, 95% CI 0.57 – 0.93), Western Finland (RR 0.60, 95% CI 0.48 – 0.76) and Northern and Eastern Finland (RR 0.62, 95% CI 0.49 – 0.79), high education level (RR 0.94, 95% CI 0.93 – 0.94), availability of OTC EC for all ages (RR 0.74, 95% CI 0.71 – 0.78), and providing free-of-charge contraception (RR 0.87, 95% CI 0.79 – 0.96).

However, the centralization of contraception services to an adolescent clinic did not associate significantly with either teenage childbirths or teenage induced abortions after adjustment (Fig. 2 and 3). Additionally, the unadjusted rate ratios for availability of OTC EC for over 15-year-olds were lower than 1 for both teenage childbirths and induced abortions, whereas the adjusted rate ratios were greater than 1 (Fig. 2 and 3). We further investigated this change by adding one variable at a time, and found the shift to occur after adjustment for high education level.

Discussion

In this study observing regional, socioeconomic and contraceptive service variables simultaneously in the 100 largest municipalities in Finland, we found that high education level and providing free-of-charge contraception were associated with lower rates of both teenage childbirth and induced abortion. While providing OTC EC only for girls older than 15 did not associate with a reduction in teenage pregnancy rates, OTC EC for all was associated with a significant reduction in both childbirth and induced abortion rates. However, we did not find a significant association between centralizing contraception services to an adolescent clinic and either the rate of teenage childbirths or that of induced abortions.

Our results on variables associated with lower teenage pregnancy rates (i.e. high education level, providing free-of-charge contraception and OTC EC for all ages) are in agreement with previous literature, except for the OTC EC. Two studies from the U.S and U.K. did not find a significant association between increased number of teenage conceptions and availability of OTC EC.[17,18]

However, at the time of these studies, the only available OTC EC pill was that of levonorgestrel. Conversely, at the time of our present study, the other approved oral medication for EC, ulipristal acetate, also became available without prescription in each municipality in 2015. The age limit for OTC EC was removed in the same year. Ulipristal acetate is significantly more effective than levonorgestrel in preventing pregnancies even if taken five days after unprotected intercourse.[22,23] This might explain in part our finding that OTC EC for all ages associated with both lower rates of teenage childbirth and induced abortion. Furthermore, the use of hormonal contraception is typically lower among younger teenagers,[2] and therefore OTC EC might have a more important role among teenagers under the age of 15 than for older teenagers in preventing unintended pregnancies. Concerning other contraceptive services, our findings are in line with previous studies that offering free-of-charge contraception associates with lower rates of teenage childbirth and induced abortion.[13,14] Although LARC methods have been shown to be the most effective contraceptives in preventing teenage pregnancies,[9] our results support also the efficacy of offering both LARC and SARC methods at no cost for teenagers. However, proper information of different contraceptive options is needed so that each teenager can choose the most suitable and effective method to use. Accordingly, in previous studies adolescents have been reported to prefer counseling with clear information about risks and benefits of contraception.[24,25]

In addition to removing the financial barrier and providing proper counseling, teenagers find that convenient location and flexible operating hours are important factors for contraceptive services.[26] Specifically, offering contraceptive services among school health care has been shown to increase the use of contraception among adolescents.[10] Furthermore, as low socioeconomic status has been shown to associate with higher teenage pregnancy rates in several previous studies, and thus easy access to low- or no-cost contraceptive services for adolescents might be especially important in areas with lower socioeconomic status.[5,6] Our results support these findings especially for the association between high education level and both lower teenage childbirth and induced abortion

rates (Figures 2 and 3). Specifically, the teenage childbirth rates were highest in Northern and Eastern Finland, where the education level is lowest and the percentage of social assistance recipients is highest (Figure 1, Table 1). However, the adjusted induced abortion rates were significantly lower in the other major regions compared to Helsinki-Uusimaa suggesting that other factors not examined in this study (e.g. access to abortion services or attitude towards induced abortion) might explain the differences between the major regions. Furthermore, the average age of first-time mothers in Finland has been highest in the capital Helsinki for over three decades being 31·5 years in 2018.[27] In contrast, the average age of first-time mothers in Northern Finland, where the degree of urbanization is lowest, was 28.0 years in 2018.[27] This was reflected also in our finding of highest teenage childbirth rate in the Northern and Eastern Finland, both with lower than average degree of urbanization.

The major strength of our nationwide study is that we examined the association of socioeconomic and contraceptive service related variables to teenage pregnancy rates simultaneously in the same study setting at the municipality level. The data relies on reliable and validated Finnish health registers covering practically all teenage childbirths and induced abortions in each municipality.[20,21] We analyzed the data annually during a long time period, from 2000 to 2018, spanning 1 900 measurement points. Additionally, the data consists of 100 largest municipalities in Finland covering 84% of the total population.

We acknowledge the following limitations of our study. The registers lack information about the intentionality of the pregnancies. However, majority of the adolescent pregnancies are reported to be unintended, as shown by Wellings et al from the U.K. in 2013.[28] In fact, the study found that 88% of 16 – 19-year-old adolescents with a history of pregnancy identified it unplanned or ambitious. [28] Another limitation is that the questionnaire to the municipalities was the only source of information on the availability of free-of-charge contraception and adolescent clinics, and these data might thus be susceptible to erroneous responses.

We conclude that providing free-of-charge contraception, both SARC and LARC methods, as well as OTC EC without age limit are associated with lower rates of both teenage childbirth and induced abortion at the municipality level. In order to reduce teenage pregnancy, health care providers and policy makers should ensure proper counseling and convenient access to high-quality contraceptive services for all adolescents regardless of their residential area or socioeconomic background. In future research, it would be important to examine how youth-friendly contraceptive services affect to the usage of different contraceptive methods in a population level, and how it associates with teenage pregnancy rates.

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Footnotes

Contributors EJ, FG, MG and OH designed the study approach. EJ and MG acquired the data, and EJ harmonized it. NK analyzed the data, and EJ, NK and FG interpreted the results. EJ produced the figures and drafted the manuscript. FG, NK, MG and OH critically revised the manuscript. All authors approved the final manuscript.

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Patient consent for publication Not required.

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Data availability statement Deidentified data are available from the authors upon reasonable request and with permission of the corresponding registers.

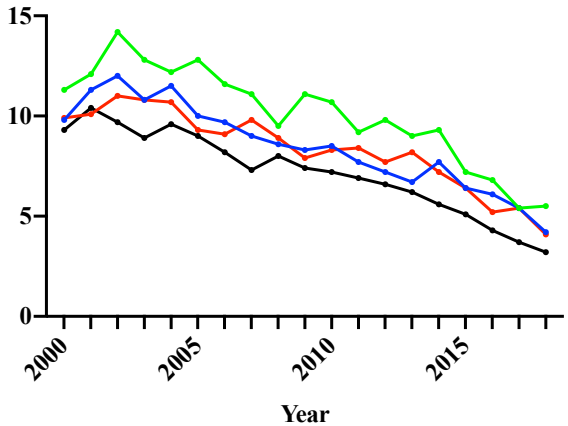
Figure legends

Figure 1. Unadjusted teenage childbirth and induced abortion rates across the follow-up from 2000 to 2018 based on the major regions in Finland.

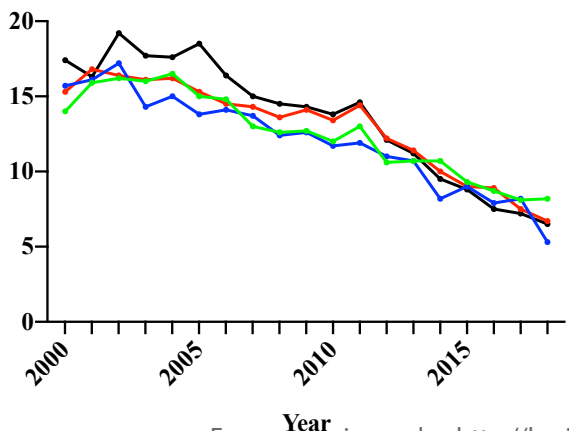
Figure 2. Unadjusted and adjusted rate ratios of variables for teenage childbirths.

Figure 3. Unadjusted and adjusted rate ratios of variables for teenage induced abortions.

Figure 1. Unadjusted teenage childbirth and induced abortion rates among the follow-up from 2000 to 2018 based on the major regions in Finland



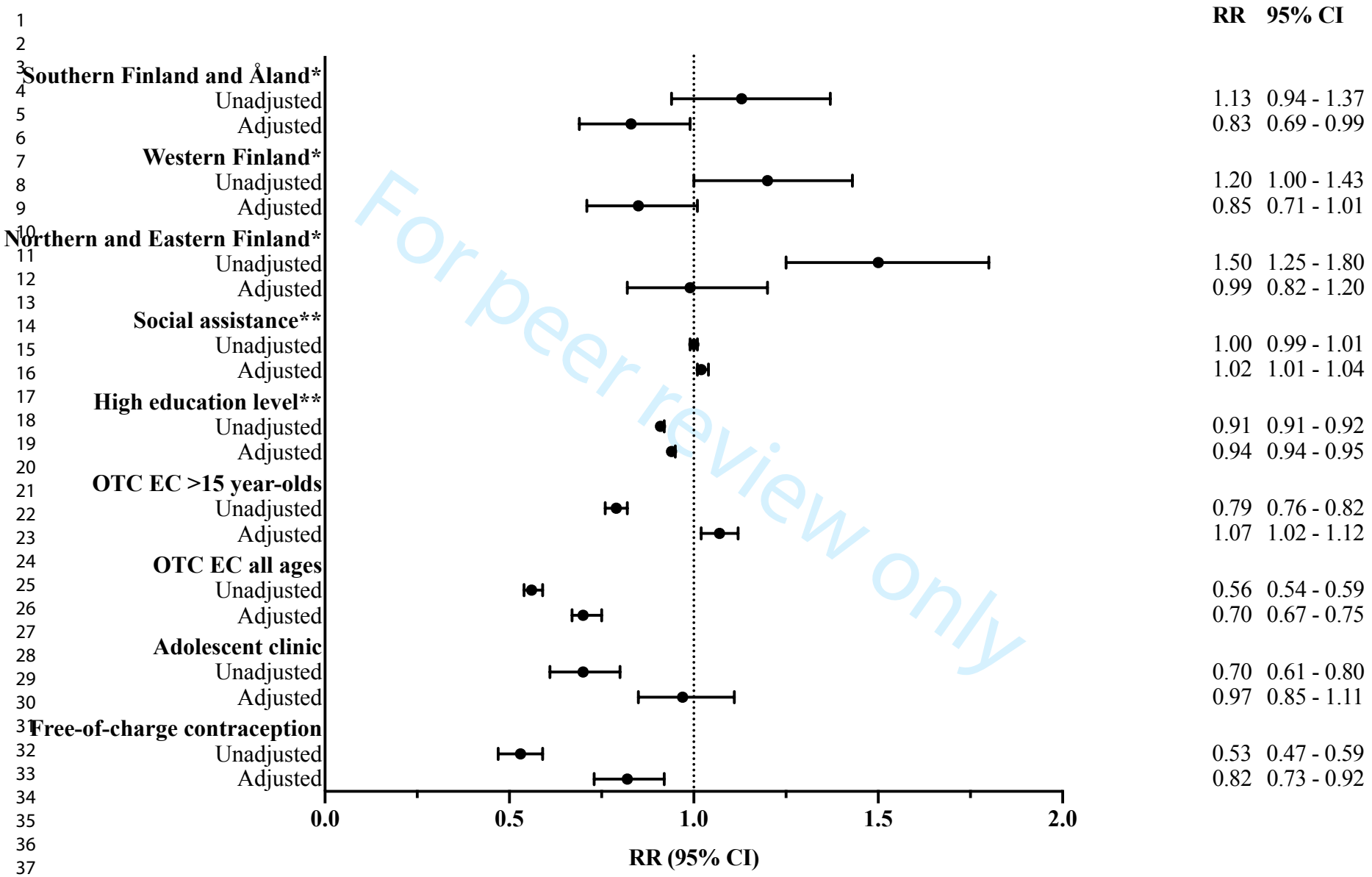
	Mean	SD
Helsinki-Uusimaa	7.02	2.07
Southern Finland and Åland	7.93	1.95
Western Finland	8.40	2.12
Northern and Eastern Finland	10.38	2.55



	Mean	SD
Helsinki-Uusimaa	12.12	3.14
Southern Finland and Åland	12.25	3.20
Western Finland	10.77	2.73
Northern and Eastern Finland	11.55	2.51

SD = standard deviation.

Figure 2. Unadjusted and adjusted rate ratios of variables for teenage childbirths.

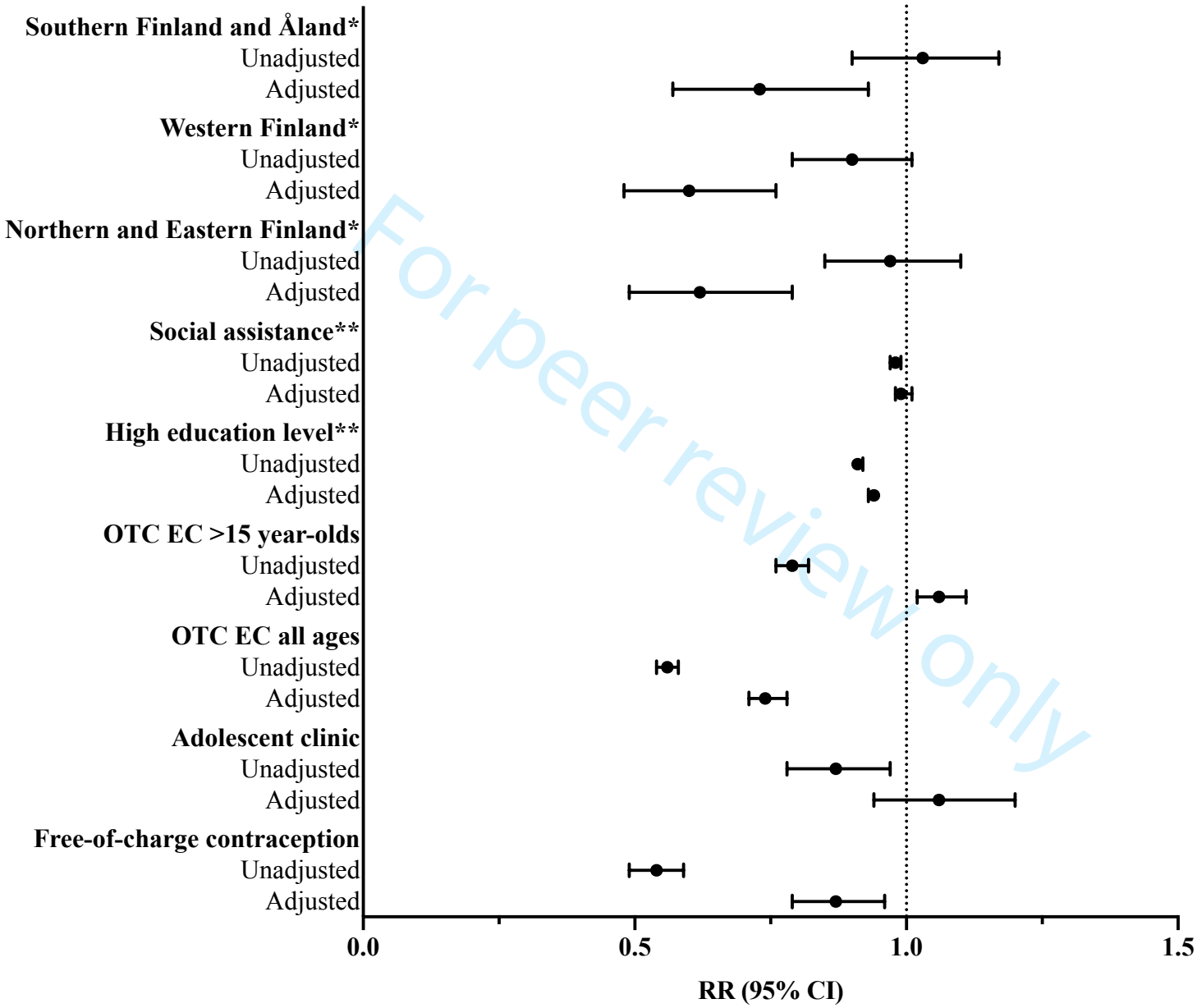


*Compared to the Helsinki-Uusimaa major region.

**Compared to one percent unit increase in social assistance resipients or citizens with high education level.

RR = rate ratio. CI = confidence interval. OTC EC = over-the-counter emergency contraception.

Figure 3. Unadjusted and adjusted rate ratios of variables for teenage induced abortions.



	RR	95% CI
Southern Finland and Åland*		
Unadjusted	1.03	0.90 - 1.17
Adjusted	0.73	0.57 - 0.93
Western Finland*		
Unadjusted	0.90	0.79 - 1.01
Adjusted	0.60	0.48 - 0.76
Northern and Eastern Finland*		
Unadjusted	0.97	0.85 - 1.10
Adjusted	0.62	0.49 - 0.79
Social assistance**		
Unadjusted	0.98	0.97 - 0.99
Adjusted	0.99	0.98 - 1.01
High education level**		
Unadjusted	0.91	0.91 - 0.92
Adjusted	0.94	0.93 - 0.94
OTC EC >15 year-olds		
Unadjusted	0.79	0.76 - 0.82
Adjusted	1.06	1.02 - 1.11
OTC EC all ages		
Unadjusted	0.56	0.54 - 0.58
Adjusted	0.74	0.71 - 0.78
Adolescent clinic		
Unadjusted	0.87	0.78 - 0.97
Adjusted	1.06	0.94 - 1.20
Free-of-charge contraception		
Unadjusted	0.54	0.49 - 0.59
Adjusted	0.87	0.79 - 0.96

*Compared to the Helsinki-Uusimaa major region.
**Compared to one percent unit increase in social assistance resipients or citizens with high education level.
RR = rate ratio. CI = confidence interval. OTC EC = over-the-counter emergency contraception.

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Municipal contraceptive services, socioeconomic status, and teenage pregnancy in Finland – a longitudinal study

Eerika Jalanko, MD[1]; Frida Gyllenberg, MD[1, 2]; Nikolas Krstic, MSc[3]; Mika Gissler, PhD[4]; Prof Oskari Heikinheimo, MD[1]

[1]Department of Obstetrics and Gynecology, University of Helsinki and Helsinki University Hospital, Finland

[2]City of Vantaa, Finland

[3]Department of Statistics, University of British Columbia, Vancouver, BC, Canada

[4]Information Services Department, THL Finnish Institute for Health and Welfare, Helsinki, Finland

Correspondence to: Oskari Heikinheimo, Department of Obstetrics and Gynecology, University of Helsinki and Helsinki University Hospital, P.O. Box 140 FIN-00029 HUS.

oskari.heikinheimo@helsinki.fi. Tel: +358 50 4271533

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Abstract

Objectives Declining teenage pregnancy rates have been linked to improved access to youth-friendly contraceptive services, but information on the combined association of these services and socioeconomic factors with teenage pregnancy is lacking.

Design and setting This retrospective longitudinal register-based study covers the annual teenage childbirth and induced abortion rates in the 100 largest municipalities in Finland in 2000-2018. We investigated the combined association of regional, socioeconomic (i.e. education level and need for social assistance) and adolescent contraceptive service variables (i.e. free-of-charge contraception, an adolescent-only clinic, and availability of over-the-counter emergency contraception (OTC EC)) with teenage childbirth and induced abortion rates at the municipality level by using Poisson mixed-effects model.

Primary outcome measures Annual teenage childbirth and induced abortion rates as numbers per 1000 teenage girls aged 15 to 19 years old in the 100 largest municipalities in Finland from 2000 to 2018.

Results The following variables were significantly associated with both lower teenage childbirth and induced abortion rates when adjusted for all the other variables used in the model: providing free-of-charge contraception (RR 0.82 [95% CI 0.73–0.92] and RR 0.87 [95% CI 0.79–0.96], respectively), availability of OTC EC without age limit (RR 0.70 [95% CI 0.67–0.75] and RR 0.74 [95% CI 0.71–0.78], respectively), and high education level of the municipality (RR 0.94 [95% CI 0.94–0.95] and RR 0.94 [95% CI 0.93–0.94], respectively).

Conclusion Providing free-of-charge contraception and availability of OTC EC without age limit are associated with lower teenage pregnancy rates. These services combined with proper counseling are thus important contents of youth-friendly contraceptive services that should be provided equally for all teenagers in order to further reduce teenage pregnancy rates.

Strengths and limitations of this study

- We investigated the association of health service and socioeconomic variables to annual teenage induced abortion and childbirth rates simultaneously in the same study setting from 2000 to 2018.
- The data, based on the reliable Finnish health registers covers practically all teenage pregnancies of the 100 largest municipalities in Finland.
- The information on the availability of free-of-charge contraception and adolescent clinics was obtained from the questionnaire to the municipalities, and might thus be exposed to erroneous responses.

Introduction

Teenage pregnancy rates have been declining in Europe and in the U.S. for over a decade, although rates of both teenage childbirth and induced abortion vary by country.[1,2,3] Childbearing in adolescence is associated with adverse obstetrical outcomes,[4] as well as with socioeconomic and educational disadvantages.[5,6] Especially repeated teen births in the U.S. cluster in counties with lower socioeconomic conditions.[5] Furthermore, women with a history of teenage pregnancy face an increased risk for psychiatric morbidity later in life.[6,7] As teenage pregnancy causes significant challenges at both the individual and the societal level, it is crucial to understand the factors associated with declining teenage pregnancy rates.

The downward trend in teenage pregnancy rates has mainly been linked to increased use of contraception,[2,3,8] especially that of long-acting reversible contraceptives (LARC) – i.e. intra uterine devices (IUD) and implants.[2,9] Further, the availability of accessible and/or affordable contraceptive services have been found to increase the use of contraception among adolescents and decrease teenage pregnancies.[10,11]

Providing free-of-charge contraceptives removes the financial barrier to contraception and associates with lower teenage pregnancy rates.[12,13] Specifically, offering free-of-charge LARC

methods has been identified as an effective approach to prevent teenage pregnancy.[12,14] In addition to reducing financial barriers, providing comprehensive sexuality education and counseling on contraception has been shown to increase adolescents' contraceptive use.[10,15,16] Moreover, expanding contraceptive services outside the clinical setting, e.g. by providing contraceptive methods over-the-counter (OTC), might potentially decrease the rate of teenage pregnancy.[17,18] However, providing OTC emergency contraception (EC) has not been shown to affect adolescent pregnancy rates.[19,20]

Despite these observations, it is crucial to take into account the socioeconomic conditions when investigating the association of contraceptive services on teenage pregnancies, and vice versa. However, studies examining the combined effects of both socioeconomic status and contraceptive services on teenage pregnancy rates are lacking. In Finland, the municipalities are obligated to offer family planning services for all citizens since 1972.[21] However, it is not specified where and how the services should be arranged. Therefore, access to contraceptive services, as well as the content of the services differs between municipalities. In this study, we used information on how the contraceptive services are arranged together with information from Finland's reliable health registers,[22] to analyze the combined effect of contraceptive service models and the socioeconomic profile of the municipalities, on the teenage pregnancy rates in the population. Specifically, our aim was to identify to what extent certain socioeconomic factors and features of contraceptive services associate with teenage pregnancy rates at the municipality level.

Methods

In this longitudinal register-based study, we investigated the association of region, educational level and socioeconomic status of the municipalities, and variables on contraceptive service provision with the annual teenage birth and induced abortion rates of the 100 largest municipalities in Finland, from 2000 to 2018. Hence, the data encompasses 1 900 measurement points across the follow-up.

In 2018, there were 311 municipalities in Finland. The total population in Finland was 5.5 million, and most of the municipalities are sparsely populated. We included the 100 largest municipalities based on the population in 2018 in this study. We considered all municipal mergers from 2000 through 2018, and the annual municipal division corresponds to that in 2018. The population in these municipalities ranged from 9 862 to 648 042 with a total of 4 631 980, and accounted for 84% of the total population in 2018.

Outcomes

Our primary outcomes were the annual rates of teenage childbirth and induced abortion in each of the 100 municipalities between 2000 and 2018. We defined teenager as being aged 15 to 19 years at the time of childbirth or induced abortion. We calculated the crude annual rates of childbirth and abortion as counts per 1000 women aged 15 to 19 years in the given municipality.

Data on childbirths and induced abortions were obtained from the Medical Birth Register and the Register of Induced Abortions, maintained by the Finnish Institute for Health and Welfare. The Medical Birth Register was established in 1987 and contains all livebirths and stillbirths with gestational age at least 22 weeks or infant weight at least 500 grams at the time of delivery, as well as data on mothers. The Register of Induced Abortions, available in electronic format since 1983, covers all induced abortions. Reporting to these registers is mandatory by law, and the accuracy of both registers is well validated.[22,23] However, these registers do not include miscarriages, i.e. pregnancies ending spontaneously before gestational weeks 22, or ectopic pregnancies. Hence, these pregnancies were not included in the study.

Explanatory variables

We assessed regional, socioeconomic and contraceptive service variables to examine the association with teenage pregnancy rates. The prevalence of the explanatory variables aggregated into four major regions are shown in Table 1.

Table 1. Prevalence of the explanatory variables in the study municipalities aggregated into four major regions.

	Helsinki-Uusimaa	Southern Finland and Åland	Western Finland	Eastern and Northern Finland	All municipalities
Socioeconomic variables (%±SD)*					
Social assistance recipients	6.1 ± 1.8	6.1 ± 1.9	5.8 ± 1.8	7.1 ± 2.1	6.3 ± 2.0
Citizens with high education level	30.0 ± 5.9	25.1 ± 4.4	24.4 ± 5.9	23.5 ± 5.3	25.2± 5.8
Contraceptive service variables**					
OTC EC for > 15-year-olds	16 (224)	24 (336)	33 (462)	27 (378)	100 (1 400)
OTC EC for all ages	16 (64)	24 (96)	33 (132)	27 (108)	100 (400)
Contraceptive services centralized to an adolescent clinic	1 (19)	4 (61)	1 (19)	1 (10)	7 (109)
Free-of-charge contraception until the age of 20 or 25	4 (5)	2 (11)	9 (20)	10 (30)	25 (66)

*Mean percentage (±SD) across the follow-up from 2000 to 2018.

**Number of municipalities offering the service, and number of municipalities offering the service together with the total number of years with the service available in parenthesis.

OTC EC = Over-the-counter emergency contraception

SD = standard deviation

To visualize the change in teenage birth and abortion rates across follow-up, we aggregated the municipalities into larger areas based on the five major regions in Finland: Helsinki-Uusimaa (Capital region), Southern Finland, Western Finland, Åland, and Northern and Eastern Finland.

However, Åland has only one municipality among the 100 municipalities included in the study, and was thus combined with Southern Finland, which is geographically closest to Åland. There were 16 municipalities in the Helsinki-Uusimaa region (population of 1 616 203 in 2018), 24 in Southern Finland and Åland (974 141), 33 in Western Finland (1 107 930) and 27 in Northern and Eastern Finland (933 706). This regional division also describes the urbanization in different parts of Finland. The degree of urbanization refers to the proportion of people living in urban settlements among the population in the region. The degree of urbanization in 2018 in Helsinki-Uusimaa was 96.4%, in Southern Finland and Åland 90.7%, in Western Finland 89.1%, and in Northern and Eastern Finland 86.4%.

To describe the socioeconomic status of the residents in the municipalities, we used the percentage of adults receiving social assistance in each municipality, and the percentage of citizens with a high education level, that is either a university, a polytechnic degree, or studies of more than three years in a vocational institution. We obtained data on social assistance recipients from the Finnish Institute for Health and Welfare, and data on educational level from Statistics Finland.

To examine the association between contraceptive services and teenage pregnancy rates we used the following variables: availability for OTC EC, municipal contraceptive services for adolescents centralized to an adolescent clinic and possibility to receive any method of contraception except condoms free of charge until the age of 20 or 25. OTC EC became available in all pharmacies in Finland for over 15-year-olds in 2002 and without age restrictions in 2015.

To obtain information on how the contraceptive services were provided, we performed a questionnaire to the municipalities concerning centralization of adolescent contraceptive services and availability of free-of-charge contraception, and when the services had become available. The questionnaire was directed to the physicians responsible for the contraceptive services in each municipality. All 100 municipalities responded the questionnaire either by email or by phone. We

received 20% of the responses from the first survey round conducted by email. The second email round increased the response rate to 60%, and the remaining responses we obtained by phone. Contraceptive services are mainly arranged in health centers, family planning clinics and/or school health care, but the initiation years of these services were not available in the responses. However, in seven municipalities the contraception services for adolescents were centralized to an adolescent clinic, and the initiation years of the clinics were available from the responses.

During 2000-2018, all municipalities offered at least a three-month supply of contraceptive pills free of charge to women initiating contraception. Altogether 25 municipalities offered all contraception free of charge until the age of 20 or 25, including pills, patches, vaginal rings, hormonal IUDs, copper IUDs and implants. The state of adolescent clinics and free-of-charge contraception varied between the municipalities, but all municipalities offering these services continued them at least until the end of 2018, and there were no breaks in the services during the follow-up.

High education level and need for social assistance in the municipalities were treated as continuous variables (percentages on the unit scale), major region as a nominal variable (values 1 to 4 according to the major region), and OTC EC, adolescent clinic and free-of-charge contraception as binary variables (values 0 or 1). Binary variables were defined as having the value zero at measurement points where and when the service was not available, and the value one where and when the service was available. OTC EC was represented by two variables, each representing the policy implemented in 2002 for over 15-year-olds and in 2015 for everyone without an age restriction.

Statistical methods

To analyze the relationships between the explanatory variables and teenage childbirth and abortion rates, we used Poisson mixed effects models with the log of the 15- to 19-year old female population in each municipality per 1000 as offset.

Initially, we had obtained several socioeconomic variables from the registers of Statistics Finland, and we used a combination of the Variance Inflation Factor (VIF), the Akaike Information Criterion (AIC), and avoidance of non-convergent models, to select which socioeconomic variables to include in the model of teenage births. We used the AIC measure during forward model selection for socioeconomic variables, but included variables on contraceptive services and regional variables in our initial model, since these were our primary variables of interest. If the inclusion of a variable resulted in the greatest reduction in AIC compared to any other variable outside of the model, then we would attempt to include the variable. However, due to potential non-convergence of the model, likely because of multicollinearity or increased model complexity, we would select the variable that resulted in the greatest reduction in AIC while preserving convergence of the model. We repeated this process until any further inclusion of variables did not reduce the AIC. Subsequently, we examined the VIF values of all variables to assess the level of multicollinearity present within the model. This selection procedure was used for modelling teenage births, while the same variables were included in the model of teenage induced abortions, to allow for direct comparisons. The model for teenage induced abortions did successfully converge. Furthermore, the VIFs in both models remained below 3 (values between 1 to 2.6), which is evidence of minimal to low multicollinearity impacting our model, and thus no factors were removed from the model. In addition to the final models, we also conducted univariate analyses for each variable included within the model without adjusting for other variables.

We present the results as rate ratios (RR) with 95% confidence intervals (CI) to assess the effect of each variable to the change in teenage birth and induced abortion rates by using comparisons appropriate for each variable. For regional variables the largest region of Helsinki-Uusimaa served as a reference level. For socioeconomic variables (i.e. the percentage of citizens with high education level and percentage of adults receiving social assistance) the rate ratios present the change in abortion and birth rates in relation to each percent unit increase in high education level or social

assistance. For contraceptive service variables (i.e. OTC EC, contraception services centralized to an adolescent clinic and free-of-charge contraception until the age of 20 or 25) the rate ratios present the change in birth and abortion rates compared to the years and municipalities where the service was not available. Statistical significance of coefficient estimates within the model was determined using a significance level of 5%.

All analyses were conducted using R version 3.5.1 (R Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/) and GraphPad Prism version 8.4.2 (GraphPad Software, San Diego, California USA, www.graphpad.com.)

Patient and public involvement

No patient involved.

Results

There were altogether 20 544 teenage childbirths and 30 696 teenage induced abortions in the 100 municipalities in the years 2000 to 2018. Figure 1 shows the aggregated rates of annual unadjusted teenage childbirth and induced abortion in the four major regions during follow-up. Both childbirth and induced abortion rates decreased in all regions over time. The childbirth rates were highest in Northern and Eastern Finland throughout the follow-up, whereas the lowest birth rates were detected in the most densely populated region Helsinki-Uusimaa. By contrast, the induced abortion rates were higher in Helsinki-Uusimaa between 2002 and 2011 when compared to the other major regions, but thereafter the differences between the regions disappeared (Figure 1).

Helsinki-Uusimaa was the most densely populated major region with total population of 1 616 203 in 16 municipalities. The highest mean percentage of adults receiving social assistance was seen in Northern and Eastern Finland, as well as the lowest percentage of citizens with high education level. Contraceptive services were most often centralized to an adolescent clinic in Western Finland, whereas free-of-charge contraception was offered most commonly in Northern and Eastern

Finland. The policies of being able to purchase OTC EC came into effect at the same time in each municipality: in 2002 for over 15-year-olds and in 2015 for all ages.

The unadjusted and adjusted rate ratios from the mixed effects Poisson regression model for teenage childbirths and induced abortions are presented in Figures 2 and 3, respectively, showing the association between different variables and teenage pregnancy rates. The following variables were associated significantly with lower teenage childbirth rates after adjustment: major region Southern Finland and Åland (RR 0.83, 95% CI 0.69 – 0.99), high education level of the municipality (RR 0.94, 95% CI 0.94 – 0.95), availability of OTC EC for all ages (RR 0.70, 95% CI 0.67 – 0.75), and providing free-of-charge contraception (RR 0.82, 95% CI 0.73 – 0.92).

For teenage induced abortions, the following variables were associated significantly with lower abortion rates after adjustment: major regions Southern Finland and Åland (RR 0.73, 95% CI 0.57 – 0.93), Western Finland (RR 0.60, 95% CI 0.48 – 0.76) and Northern and Eastern Finland (RR 0.62, 95% CI 0.49 – 0.79), high education level of the municipality (RR 0.94, 95% CI 0.93 – 0.94), availability of OTC EC for all ages (RR 0.74, 95% CI 0.71 – 0.78), and providing free-of-charge contraception (RR 0.87, 95% CI 0.79 – 0.96).

However, the centralization of contraception services to an adolescent clinic did not associate significantly with either teenage childbirths or teenage induced abortions after adjustment (Fig. 2 and 3). Additionally, the unadjusted rate ratios for availability of OTC EC for over 15-year-olds were lower than 1 for both teenage childbirths and induced abortions, whereas the adjusted rate ratios were greater than 1 (Fig. 2 and 3). We further investigated this change by adding one variable at a time, and found the shift to occur after adjustment for high education level.

Discussion

In this study observing regional, and municipal socioeconomic and contraceptive service variables simultaneously in the 100 largest municipalities in Finland, we found that high education level of the municipality and providing free-of-charge contraception were associated with lower rates of

both teenage childbirth and induced abortion. While providing OTC EC only for girls older than 15 did not associate with a reduction in teenage pregnancy rates, OTC EC for all was associated with a significant reduction in both childbirth and induced abortion rates. However, we did not find a significant association between centralizing contraception services to an adolescent clinic and either the rate of teenage childbirths or that of induced abortions.

Our results on variables associated with lower teenage pregnancy rates (i.e. high education level, providing free-of-charge contraception and OTC EC for all ages) are in agreement with previous literature, except for the OTC EC. Two studies from the U.S and U.K. did not find a significant association between increased number of teenage conceptions and availability of OTC EC.[19,20] However, at the time of these studies, the only available OTC EC pill was that of levonorgestrel. Conversely, at the time of our present study, the other approved oral medication for EC, ulipristal acetate, also became available without prescription in each municipality in 2015. The age limit for OTC EC was removed in the same year. Ulipristal acetate is significantly more effective than levonorgestrel in preventing pregnancies even if taken five days after unprotected intercourse.[24,25] This might explain in part our finding that OTC EC for all ages associated with both lower rates of teenage childbirth and induced abortion. Furthermore, the use of hormonal contraception is typically lower among younger teenagers,[2] and therefore OTC EC might have a more important role among teenagers under the age of 15 than for older teenagers in preventing unintended pregnancies. Concerning other contraceptive services, our findings are in line with previous studies that offering free-of-charge contraception associates with lower rates of teenage childbirth and induced abortion.[13,14] Although LARC methods have been shown to be the most effective contraceptives in preventing teenage pregnancies,[9] our results support also the efficacy of offering both LARC and short-acting reversible contraceptive (SARC) methods at no cost for teenagers. However, proper information of different contraceptive options is needed so that each teenager can choose the most suitable and effective method to use. Accordingly, in previous studies adolescents have been

reported to prefer counseling with clear information about risks and benefits of contraception.[26,27] Although proper counseling is ensured in adolescent clinics we found no significant association between centralizing contraceptive services to an adolescent clinic and lowering teenage pregnancy rates. This might be due to the fact that there were only seven municipalities offering contraceptive services in a centralized adolescent clinic in our data. In addition, it has been shown that teenagers find convenient location and flexible operating hours as important factors for contraceptive services.[28] Specifically, offering contraceptive services within school health care has been shown to increase the use of contraception among adolescents.[10] Thus, convenient location and flexible operating hours might play a more remarkable role for teenagers seeking contraceptive services than a specialized adolescent clinic.

Furthermore, as low socioeconomic status has been shown to associate with higher teenage pregnancy rates in several previous studies, and thus easy access to low- or no-cost contraceptive services for adolescents might be especially important in areas with lower socioeconomic status.[5,6] Our results support these findings especially for the association between high education level and both lower teenage childbirth and induced abortion rates (Figures 2 and 3). Specifically, the teenage childbirth rates were highest in Northern and Eastern Finland, where the education level is lowest and the percentage of social assistance recipients is highest (Figure 1, Table 1). However, the adjusted induced abortion rates were significantly lower in the other major regions compared to Helsinki-Uusimaa suggesting that other factors not examined in this study (e.g. access to abortion services due to longer distances or less favorable attitude towards induced abortion) might explain the differences between the major regions. Furthermore, the average age of first-time mothers in Finland has been highest in the capital Helsinki for over three decades being 31.5 years in 2018.[29] In contrast, the average age of first-time mothers in Northern Finland, where the degree of urbanization is lowest, was 28.0 years in 2018.[29] This was reflected also in our finding of highest

teenage childbirth rate in the Northern and Eastern Finland, both with lower than average degree of urbanization.

The major strength of our nationwide study is that we examined the association of socioeconomic and contraceptive service related variables to teenage pregnancy rates simultaneously in the same study setting at the municipality level. The data relies on reliable and validated Finnish health registers covering practically all teenage childbirths and induced abortions in each municipality.[22,23] We analyzed the data annually during a long time period, from 2000 to 2018, spanning 1 900 measurement points. Additionally, the data consists of the 100 largest municipalities in Finland covering 84% of the total population.

We acknowledge the following limitations of our study. Although we examined the association of several variables with declining teenage pregnancy rates there are other possible factors as well that might have affected to the lowering rates of both teenage induced abortions and childbirths. For instance, adolescent sexual behavior and substance use might have changed across the follow-up. However, we were not able to investigate the possible association of these variables with the teenage pregnancy rates. Furthermore, all data are on the municipal level, and thus we lack information of the socioeconomic status of the individuals. However, variables of socioeconomic status are not available for teenagers, and hence these aggregated data provide a proxy for their socioeconomic status. Another limitation is that the registers lack information about the intentionality of the pregnancies. However, the majority of the adolescent pregnancies are reported to be unintended, as shown by Wellings et al. from the U.K. in 2013.[30] In fact, the study found that 88% of 16 – 19-year-old adolescents with a history of pregnancy identified it as unplanned or ambitious.[30] In addition, the questionnaire to the municipalities was the only source of information on the availability of free-of-charge contraception and adolescent clinics, and these data might thus be susceptible to erroneous responses.

We conclude that providing free-of-charge contraception, both SARC and LARC methods, as well as OTC EC without age limit are associated with lower rates of both teenage childbirth and induced abortion at the municipality level. In order to reduce teenage pregnancy, health care providers and policy makers should ensure provision of free-of-charge contraception combined with proper counseling and convenient access to high-quality contraceptive services for all adolescents regardless of their residential area or socioeconomic background. In future research, it would be important to examine how youth-friendly contraceptive services affect the usage of different contraceptive methods in a population level, and how it associates with teenage pregnancy rates.

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Footnotes

Contributors EJ, FG, MG and OH designed the study approach. EJ and MG acquired the data, and EJ harmonized it. NK analyzed the data, and EJ, NK and FG interpreted the results. EJ produced the figures and drafted the manuscript. FG, NK, MG and OH critically revised the manuscript. All authors approved the final manuscript.

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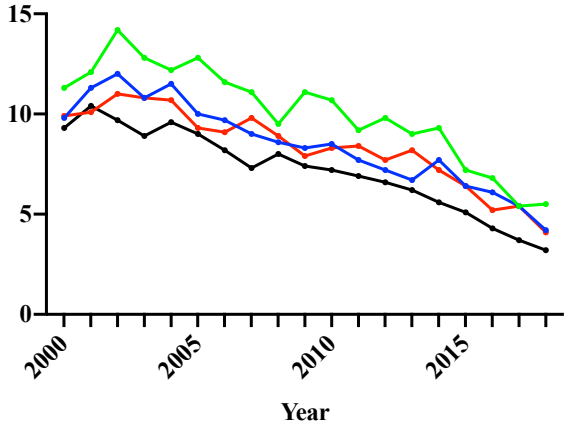
Figure legends

Figure 1. Unadjusted teenage childbirth and induced abortion rates across the follow-up from 2000 to 2018 based on the major regions in Finland.

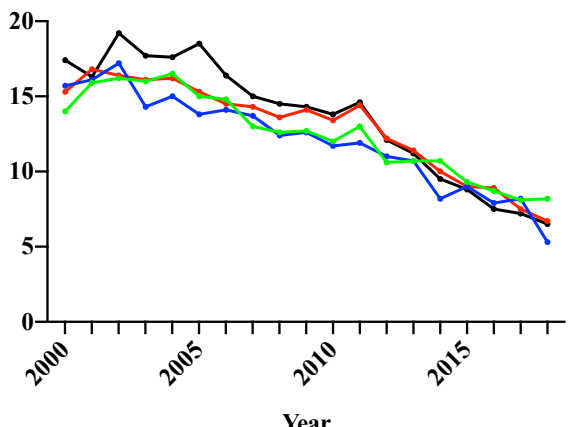
Figure 2. Unadjusted and adjusted rate ratios of variables for teenage childbirths.

Figure 3. Unadjusted and adjusted rate ratios of variables for teenage induced abortions.

Figure 1. Unadjusted teenage childbirth and induced abortion rates by the follow-up from 2000 to 2018 based on the major regions in Finland



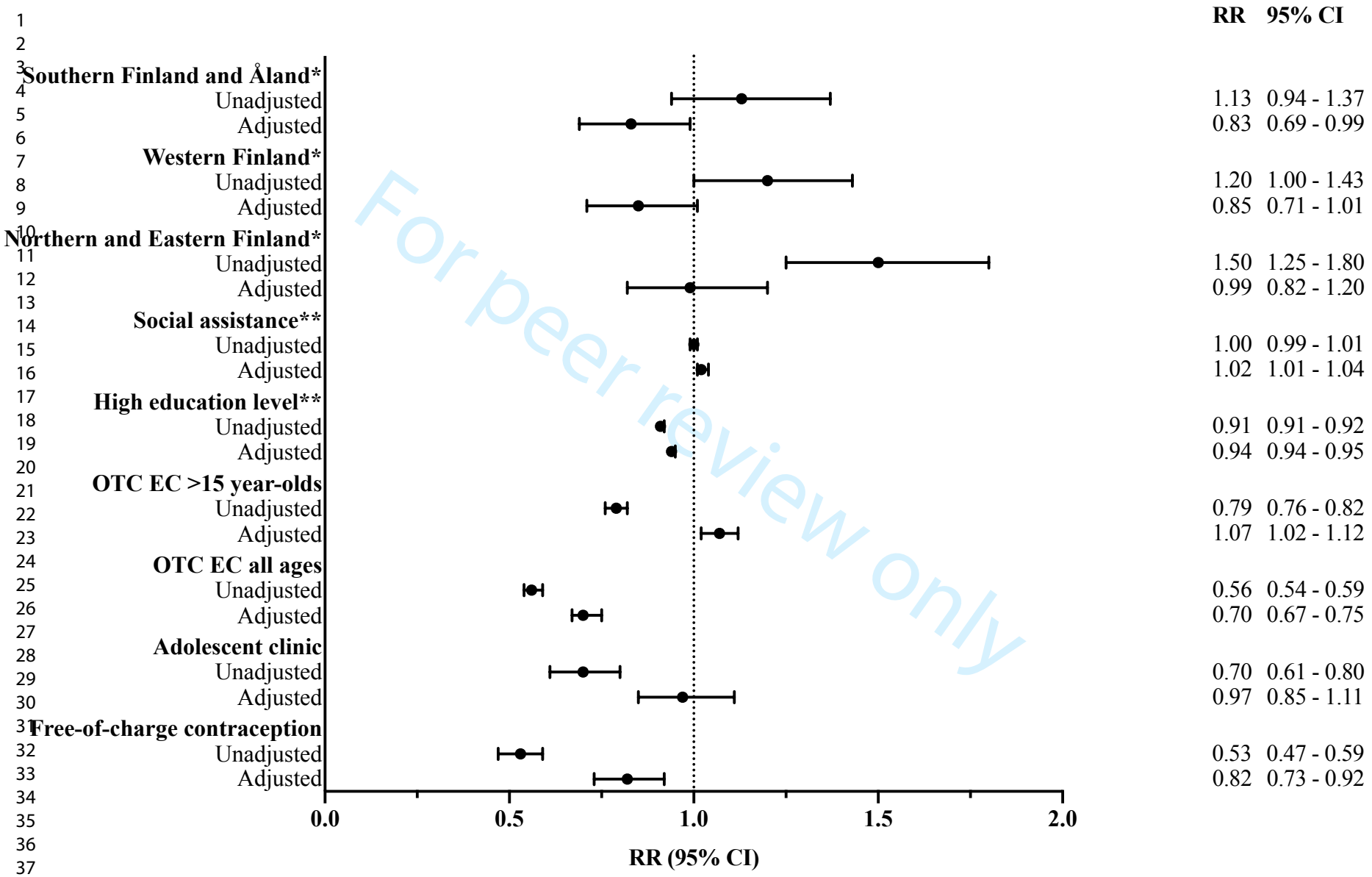
	Mean	SD
Helsinki-Uusimaa	7.02	2.07
Southern Finland and Åland	7.93	1.95
Western Finland	8.40	2.12
Northern and Eastern Finland	10.38	2.55



	Mean	SD
Helsinki-Uusimaa	12.12	3.14
Southern Finland and Åland	12.25	3.20
Western Finland	10.77	2.73
Northern and Eastern Finland	11.55	2.51

SD = standard deviation.

Figure 2. Unadjusted and adjusted rate ratios of variables for teenage childbirths.

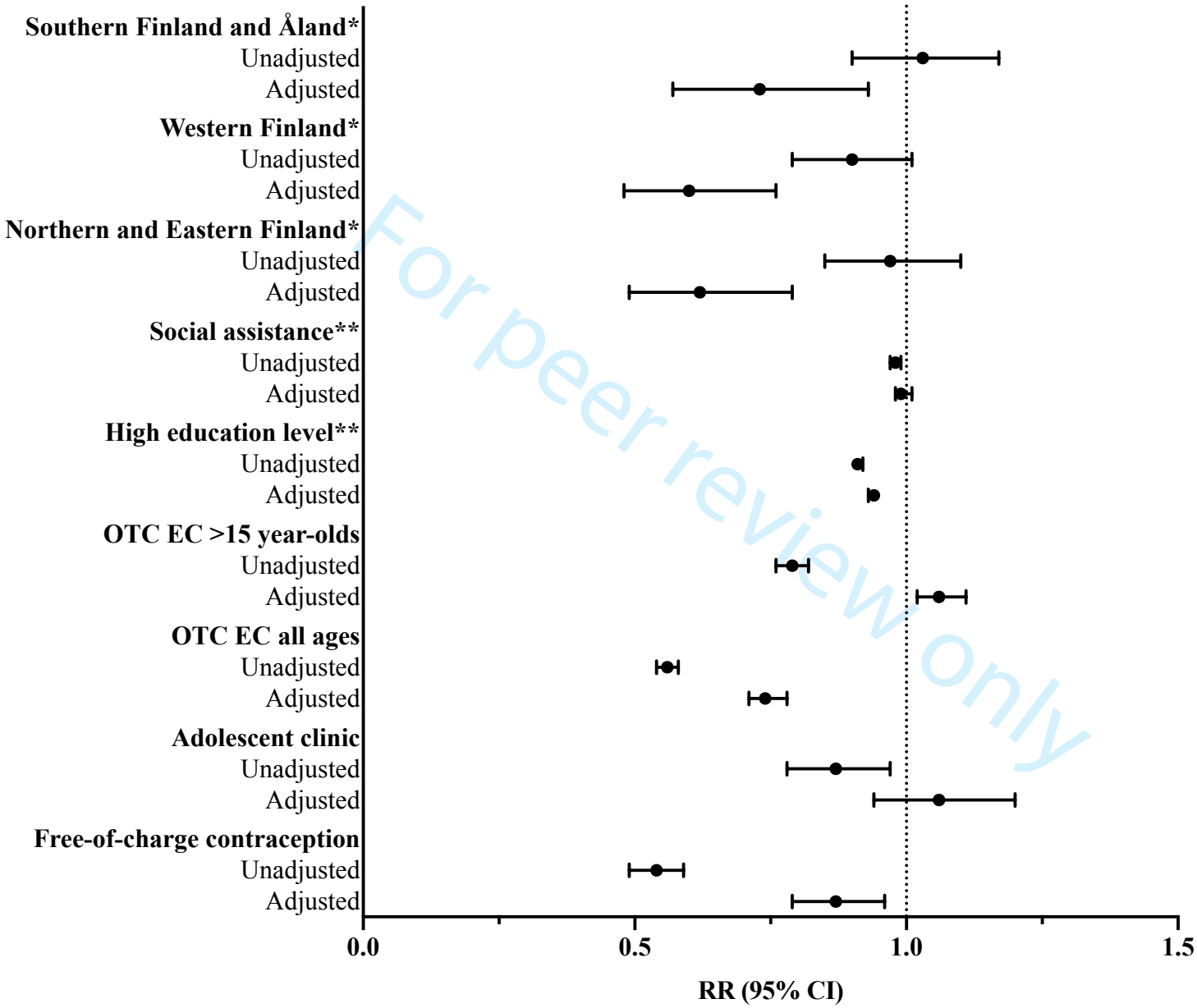


*Compared to the Helsinki-Uusimaa major region.

**Compared to one percent unit increase in social assistance resipients or citizens with high education level.

RR = rate ratio. CI = confidence interval. OTC EC = over-the-counter emergency contraception.

Figure 3. Unadjusted and adjusted rate ratios of variables for teenage induced abortions.



*Compared to the Helsinki-Uusimaa major region.

**Compared to one percent unit increase in social assistance resipients or citizens with high education level.

RR = rate ratio. CI = confidence interval. OTC EC = over-the-counter emergency contraception.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5,7,8
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	8-10
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	10
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	10
Outcome data	15*	Report numbers of outcome events or summary measures over time	10

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	11,12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12,13
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.